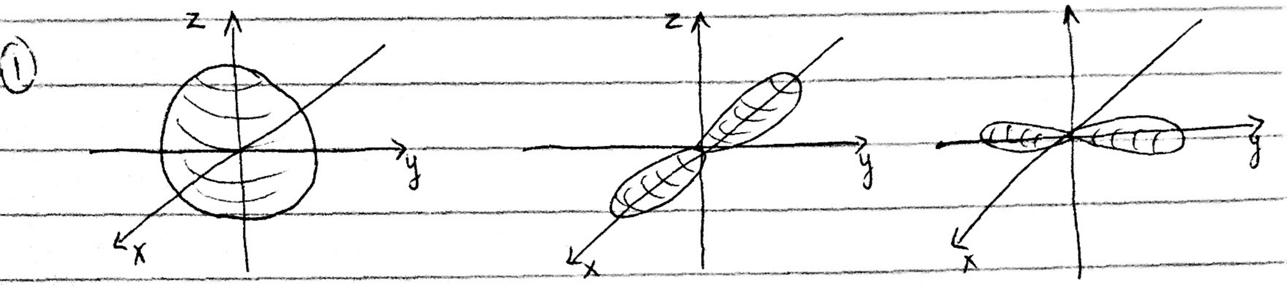
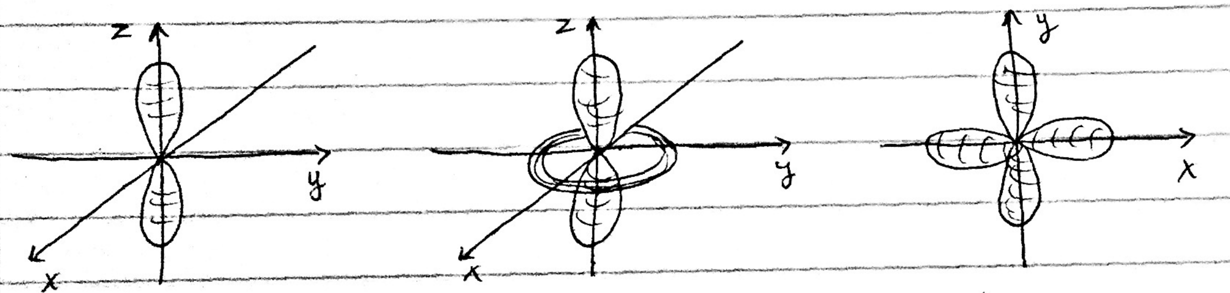
Problem Set # 3

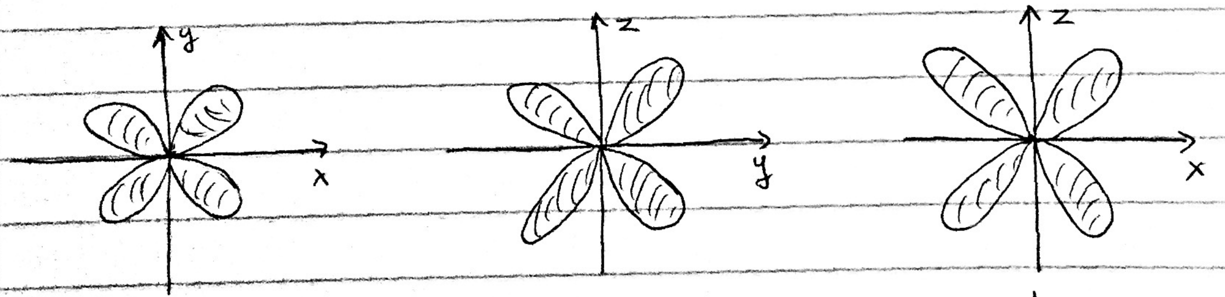
1



s p_x p_y



p_z d_{z^2} $d_{x^2-y^2}$



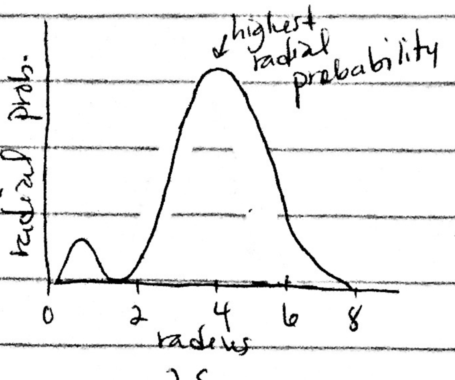
d_{xy} d_{yz} d_{xz}

2

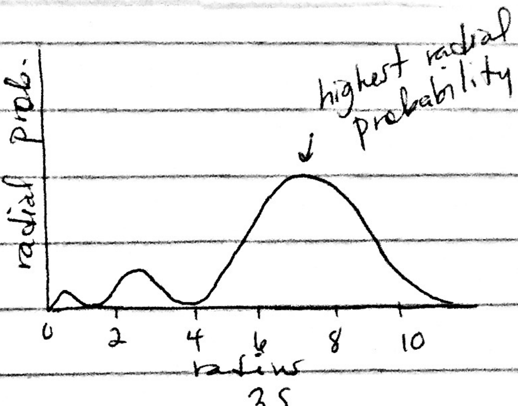
3s	$n=3$	$l=0$
2p	$n=2$	$l=1$
3d	$n=3$	$l=2$
4f	$n=4$	$l=3$

3 sets (b) & (c) are not allowed

4



2S



3S

On average, an electron in a 2S orbital will be closer to the nucleus.

5 (a) $n=3$ $l=1$ $\Rightarrow m_l = -1, 0, 1$ (3 orbitals)

$m_s = +\frac{1}{2}$ (only one e^- per orbital)

$\Big\}$ $3\ e^-s$

(b) $n=5$ $l=3$ $\Rightarrow m_l = -3, -2, -1, 0, 1, 2, 3$ (7 orbitals)

two e^-s per orbital

$\Big\}$ $14\ e^-s$

(c) $n=4$ $\Rightarrow$ $l=0$ $m_l = 0$

$l=1$ $m_l = -1, 0, 1$ (16 orbitals)

$l=2$ $m_l = -2, -1, 0, 1, 2$

$l=3$ $m_l = -3, -2, -1, 0, 1, 2, 3$

$m_s = -\frac{1}{2}$ (only one per orbital)

$\Big\}$ $16\ e^-s$

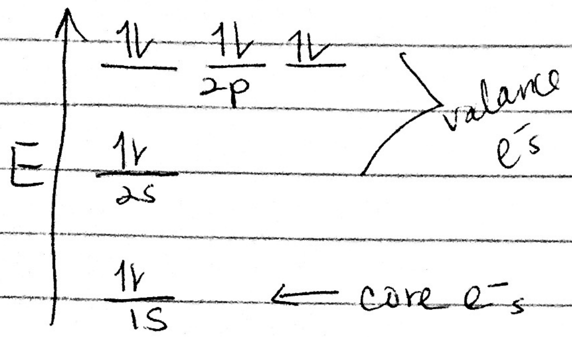
6 Si: $1s^2 2s^2 2p^6 3s^2 3p^2$ ($14 e^-s$)

Mn: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$ ($25 e^-s$)

Rb^+: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6$ ($36 e^-s$)

O: $1s^2 2s^2 2p^4$ ($8 e^-s$)

7 Atomic Number: 10 Ne



no unpaired e⁻s

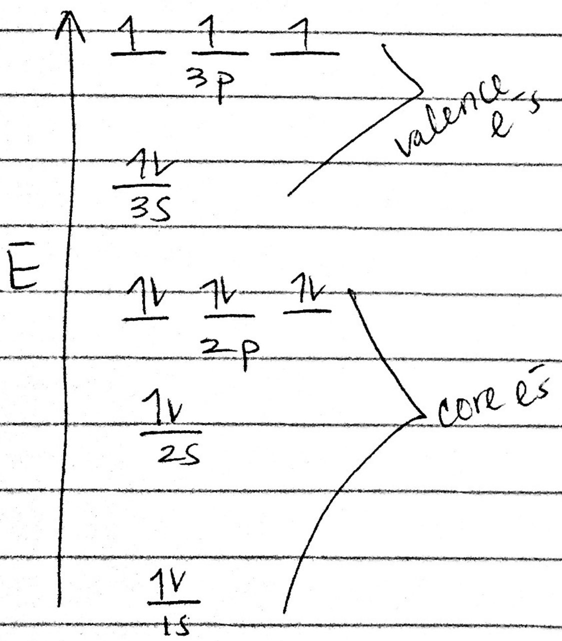
2 core e⁻s

8 valance e⁻s

valence e⁻s ⇐ highest n

core e⁻ ⇐ every other e⁻ (lower ns)

Atomic Number: 15 → Phosphorus



3 unpaired e⁻s

10 core e⁻s

5 valence e⁻s

8 (a) Krypton

(b) Tin

9 (a) N: $1s^2 2s^2 2p^3$
Mg: $1s^2 2s^2 2p^6 3s^2$
O: $1s^2 2s^2 2p^4$
F: $1s^2 2s^2 2p^5$
Al: $1s^2 2s^2 2p^6 3s^2 3p^1$

(b) Mg > Al > N > O > F

(c) $\underbrace{Al < Mg}_{\text{exception}} < \underbrace{O < N}_{\text{exception}} < F$

(d) Aluminum's first ionization energy is lower than Mg because its 3p electron is shielded by the 3s orbital (3p higher in energy than 3s). Oxygen's first ionization energy is lower than that of N because its fourth 2p electron experiences electron-electron repulsion by the other electron in its orbital.

10 K: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$ $\Longrightarrow$ K^+: $1s^2 2s^2 2p^6 3s^2 3p^6$
Ar: $1s^2 2s^2 2p^6 3s^2 3p^6$

Argon's outer electron shell is filled, giving it chemical stability. Potassium has one more electron than Ar and has a low ionization energy. Potassium tends to easily lose an electron, giving the potassium cation stability due to the full 3s & 3p subshells which correspond to argon's chemically stable electron configuration.